Application study of image segmentation methods on pattern recognition in the course of wood across-compression[1]

Cao Jun(曹军)* Sun Liping(孙丽萍) Zhang Dongyan(张冬妍) Jiang Yu(姜宇)

Northeast Forestry University, Harbin 150040, P. R. China

Abstract Image segmentation is one of important steps on pattern recognition study in the course of wood across-compression. By comparing and studying processing methods on finding cell space and cell wall, this paper puts forward some image segmentation methods that are suitable for study of cell images of wood cross-grained compression. The method of spline function fitting was used for linking edges of cell, which perfects the study of pattern recognition in the course of wood across-compression.

Keywords: Image segmentation, Pattern recognition, wood across-compression, Spline function.

Introduction

Pattern recognition is one of important embranchments in artificial intelligence, and is a new absolute subject that has become one of significant fields of high-tech study and application nowadays. Image segmentation method of pattern recognition is used by wood across compression in this paper. By using computer disposal to cell image, pattern recognition can be achieved for which the aim of studying cell deformation regularity at different compression rate and quantitative analysis can be changed from qualitative analysis in wood across compression technology.

Pattern recognition stage

A condition containing figure image of many objects is given. Pattern recognition is composed of three main stages (Fig. 1)

To study cell image, the first step taken is extracting "interesting" district or target, which will bring great influence on accuracy rate of the classification and decision-making latter day. So this paper carries comparative research to segmentation problem of the wood cell image (object gotten problem).

Achieving of image segmentation method

Image segmentation method is the course that divides digital image into mutually exclusive district. It can be realized by appointing object pixels or finding boundary in objects. Three classes will be discussed by taking different ways and theories for image segmentation of wood cell image.

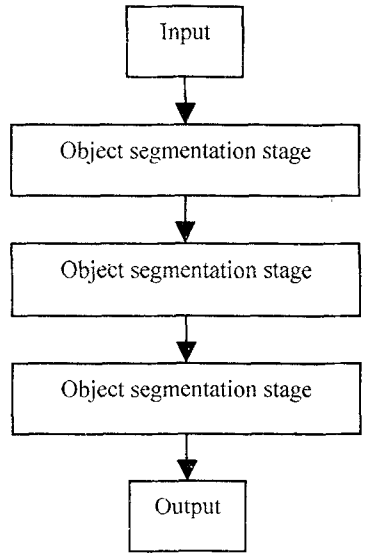

Fig. 1. Flow chart of image processing

Region method

The threshold method and region growing method are used to change original image into bilevel image.

Threshold method

Taking threshold techniques is very useful to segmenting scene that has strong matching between object and background. It uses gray-level frequency distributing information to segment. Its basal principle is: set original gray-level image to $f(x,y)$, bilevel image segmented is $g(x,y)$.

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*Cao Jun: male, born in 1956. Prof. and Vice president of Northeast Forestry University

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$$g(x,y)=\begin{cases}1 & f(x,y)\geq T_0\\ 0 & f(x,y)<T_0\end{cases}$$

where, the T_0 is the gray-level threshold value which has been found in $f(x,y)$ by certain rule.

This method is easy to complete and has a little computational complexity. But if the threshold value selected was too lower, many object points would be ranged to background wrong; if the threshold value is higher, many scene would be classified to object points by wrong. Using optimal binary segmentation method in clustering analysis, calculating all kinds of gray-level average value and variance, the gray-level value corresponding to the minimal value in classes was selected as threshold value. Fig. 2 shows the result of image processing

Region growing method

This method completes segmentation by means of local place information and uses place structure relationship in pixels and other characters. By weighting similarity of the cell wall (background point) and cell space (object point) in images to gray-level average and variance, the pixel points can be classified and cell images two-value can be achieved. The way as follows:

$$A(i,j;k,l)=\sum_{i=1}^{n}\left|P_i(i,j)-P_i(k,l)\right|$$

$$L(i,j;k,l)=\sum_{i=1}^{n}\left|P_i(i,j)-P_i(k,l)\right|^2$$

In it, (k,l) is another pixel point. The effectiveness image as follows.

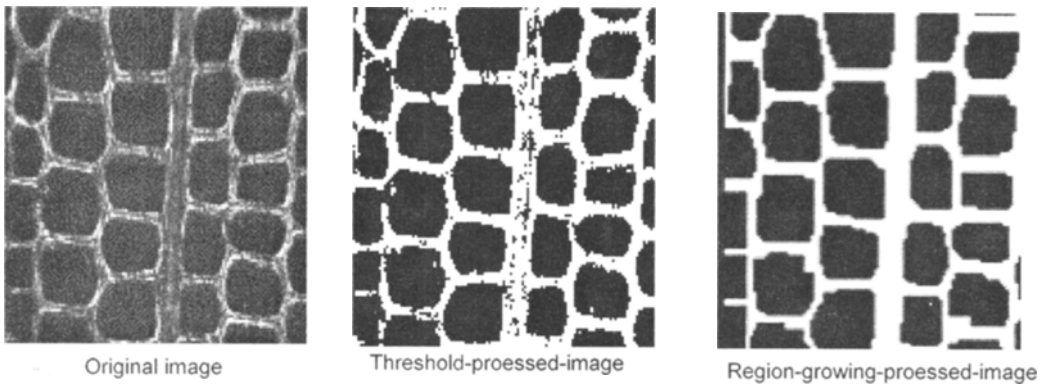

Fig 2. Effectiveness images on segmentation

Verge Method

In image segmentation, we call the segmentation by assuring boundary existing in regions as region method. Laplacian operator is the one such as this to complete verges buildup and detecting. It will emerge a sharp zero crossing at the verges that are linear and invariant shift operator. Its convolution kernel of the convolution operation is expressed as:

$$p(x,y)=\begin{bmatrix}0 & 1 & 0\\ 1 & -4 & 1\\ 0 & 1 & 0\end{bmatrix}$$

The wood cell images two-valued by laplacian operator are shown as Fig. 3.

Edge method

In image segmentation, there is another edge segmentation method to confirm edge pixel first and link them together to make the needed verge. There are Roberts, Sobel, Prewitt, Kirsh verge operators that are often used. In them, Roberts is 2×2 operator which is the best one to respond to the images that have sharp low noise. But to the cell images studied in the course of wood across compression that have certain noise and gliding gray-level, adopting Sobel 3 ×3 verge operator is good to deal with images that have gray-level gliding and more noise.

Sobel operator

Sobel operator is a kind of nonlinear method. It is often completed by horizontal and vertical convolution kernel of convolution operator. The two convolution kernels as follows:

$$S_x=\begin{vmatrix}-1 & 0 & 1\\ -2 & 0 & 2\\ -1 & 0 & 1\end{vmatrix}\qquad S_y=\begin{vmatrix}1 & 2 & 1\\ 0 & 0 & 0\\ -1 & -2 & -1\end{vmatrix}$$

Their mathematical expressions are:

$$g_1(x,y)=\sum_{k=-1}^{1}\sum_{l=-1}^{1}S_x(k+1,l+1)\cdot f(x+k,y+l)$$

$$g_2(x,y)=\sum_{k=-1}^{1}\sum_{l=-1}^{1}S_y(k+1,l+1)\cdot f(x+k,y+l)$$

If $g_1(x,y)>g_2(x,y)$ then it shows that there are vertical verges traveling through at pixel point (x, y). Then again, there are horizontal ones traveling through. The image processed is given as follows(Fig. 3).

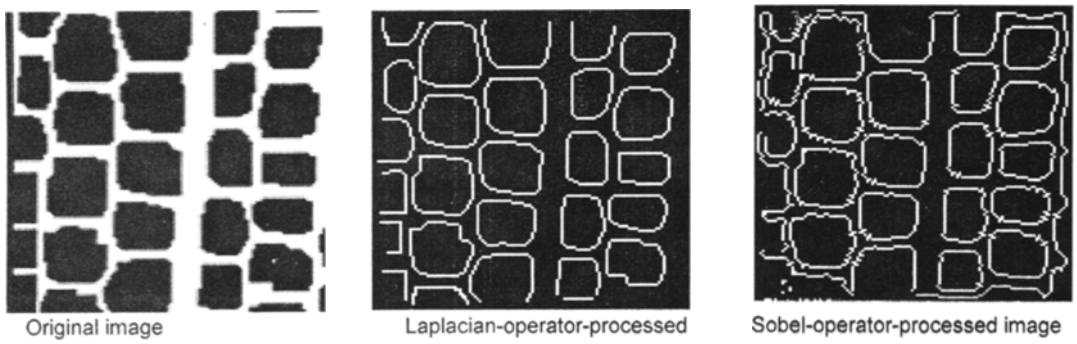

Fig. 3. Effectiveness images on edge detection

Verge linking

Taking feature parameters is processed in verge images. A verge image sketches all objects outline using verge points. But in nonideal condition (including logging in cell image, smoothness, bilevel and so on.), notches often appear on verge images which needs to link and replenish to assure universality and accuracy rate when getting parameters.

The replenish way is confirmed based on different verge points breaking of connecting length. To interstitial gap, heuristic search is a wonderful linking method in which calculating would be very complicated if there are a lot of gaps function. So this method is fit for doing with the lesser gaps. If there are many gaps, then linking can be accomplished by using linear interpolation or spline function. Thrice spline function fitting is taken in this paper which aims at single pixel verge image.

If verge points are very sparse, then the spline function can fit these points to form a boundary to take objects. So Freeman chain codes knowledge can be used to find edge in this paper that study verge images. According to "the leftest trace algorithm" scans row and column to find the first end point of the gaps. In virtue of thrice spline taken in natural condition links with interpolation. The visualized method as follows:

(1) Scanning images according to rows、columns, judging when meeting the unattached, recording the first end point;

(2) Making the first end point as the start point, scanning first based on the last right, searching the second point and recording its coordinate values;

(3) Recording 5 coordinates before the first end point and constructing spline function using the 7 points;

(4) According to Freeman codes, grouping 8 points of neighboring region into 4 (1, 0, 7; 3, 4, 5; 2; 6) and replenishing between two end points.

Conclusion

Bilevel images laded by region growing method are more integrate than those laded by threshold method.

Sobel operator is not sensitive to noise of image, but sharpened degree of edge transformed by laplacian operator is well. To some extent, laplacian operator has repressive effect on noise, so it is a better verge segmentation method.

The paper used thrice spline function fitting method, and solved the matter of edge linking.

Above method studies established basis of characteristic quantity abstraction and analysis.

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